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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	10718913
	Filing Date	2003-11-21 FAX RECEIVED
	First Named Inventor	McBean, John M. ~~OCT 1 6 2007~~
	Art Unit	3764
	Examiner Name	Brown, Michael A. OFFICE OF PETITIONS
	Attorney Docket Number	1118/A04

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	3631542		1972-01-04	Iowa State University Research Foundation	

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☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David J. Zwick, Reg. #41393/	Date (YYYY-MM-DD)	2007-10-16
Name/Print	David J. Zwick	Registration Number	41,393

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United States Patent

[11] 3,631,542

[72] Inventor Allan G. Potter
Ames, Iowa
[21] Appl. No. 848,919
[22] Filed Aug. 11, 1969
[45] Patented Jan. 4, 1972
[73] Assignee Iowa State University Research Foundation
Ames, Iowa

[54] MYOELECTRIC BRACE
2 Claims, 6 Drawing Figs.

[52] U.S. Cl. 3/1.1, 3/1.2, 128/26, 128/77
[51] Int. Cl. A61f 1/00, A61f 5/10
[50] Field of Search 3/1–1.2; 128/26, 77

[56] References Cited
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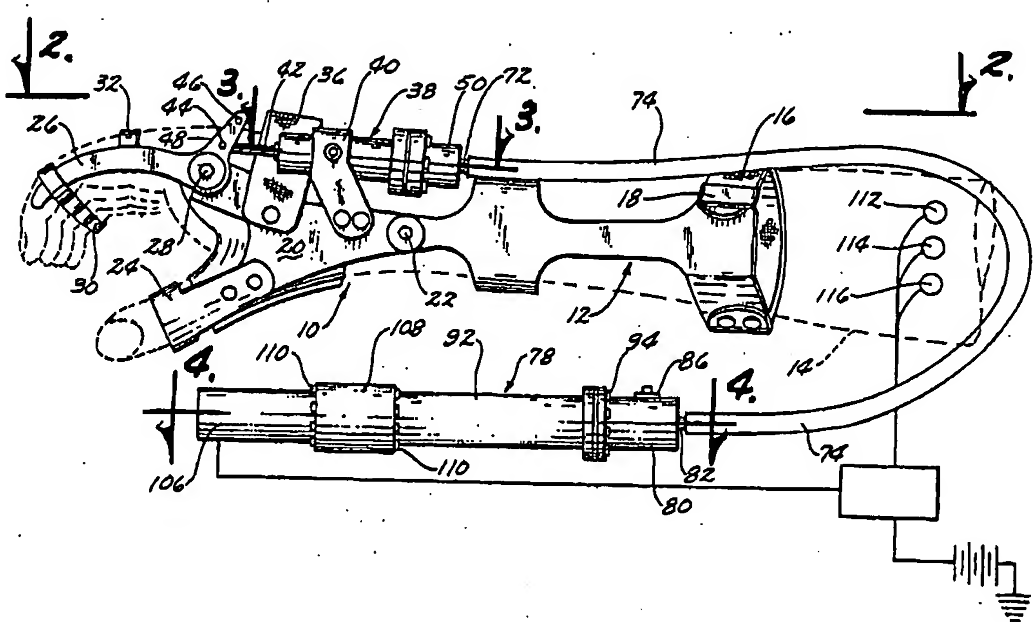
Primary Examiner—Richard A. Gaudet
Assistant Examiner—Ronald L. Frinks
Attorney—Zarley, McKee & Thomte

ABSTRACT: A myoelectric brace consisting of a fixed wrist-hand splint portion having a movable finger support portion pivotally secured thereto which is operated by a hydraulic actuator. The actuator is hydraulically coupled to a pump which is driven by a battery powered, direct current motor. Three skin electrodes are positioned on the patient's arm and sense muscle potentials in the patient's arm when the patient tenses a muscle in the immediate area of the skin electrodes. The resulting myo-potentials are then amplified by a muscle potential amplifier and are transformed into a slowly varying control signal by a detector circuit and a filter circuit. The control signal enters a differential amplifier where it causes the motor to drive the hydraulic pump until a predetermined pressure is reached. Actuation of the hydraulic pump causes the hydraulic actuator to pivotally move the finger support towards the fixed splint portion. The motor stops when the differential amplifier receives a signal from the pressure transducer equal in amplitude to the control signal. This causes the differential amplifier output signal to go to zero. Relaxation of the patient's muscle causes the finger support to pivotally move away from the fixed splint portion.



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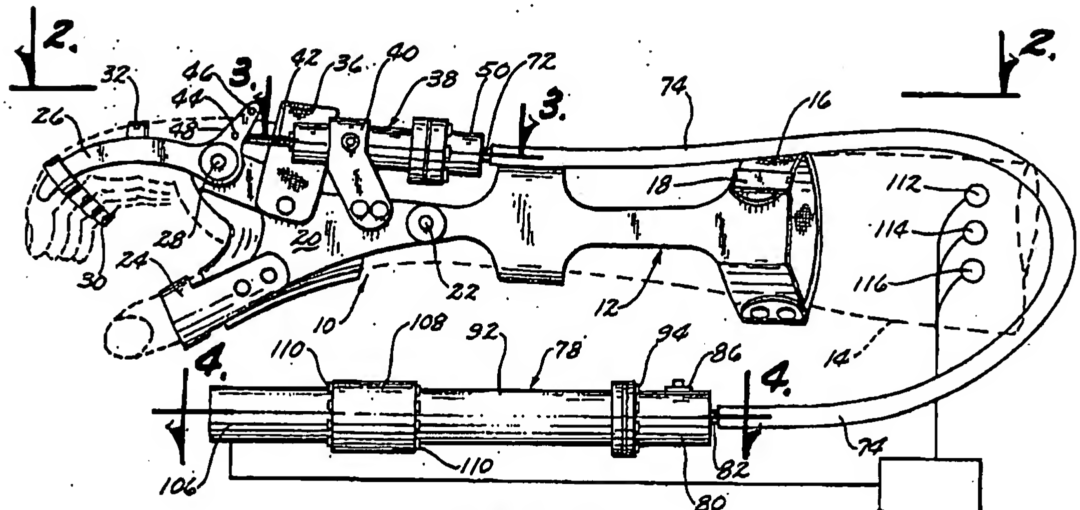

Fig. 1

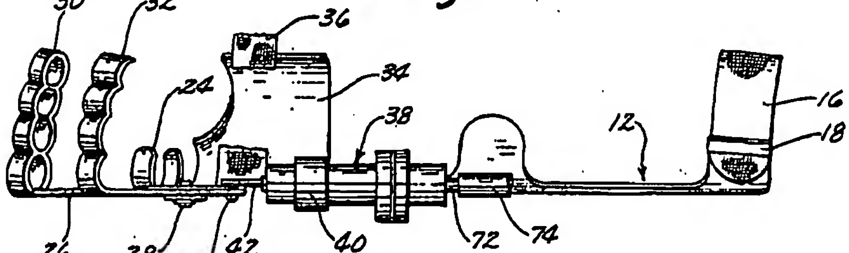

Fig. 2

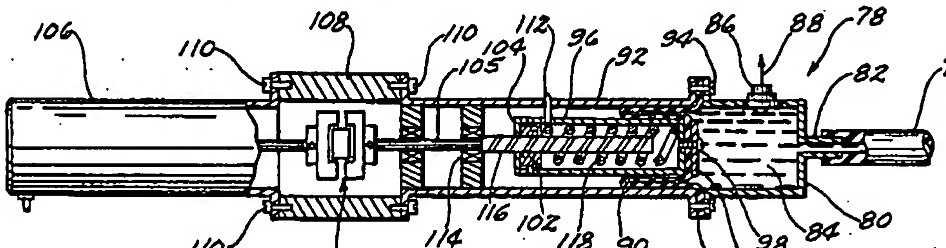

Fig. 4

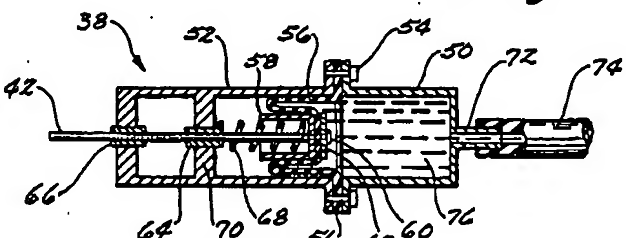

Fig. 3

INVENTOR
ALLAN G. POTTER
BY
Zarley, McKee & Thomte
ATTORNEYS

PATENTED JAN 4 1972 3,631,542

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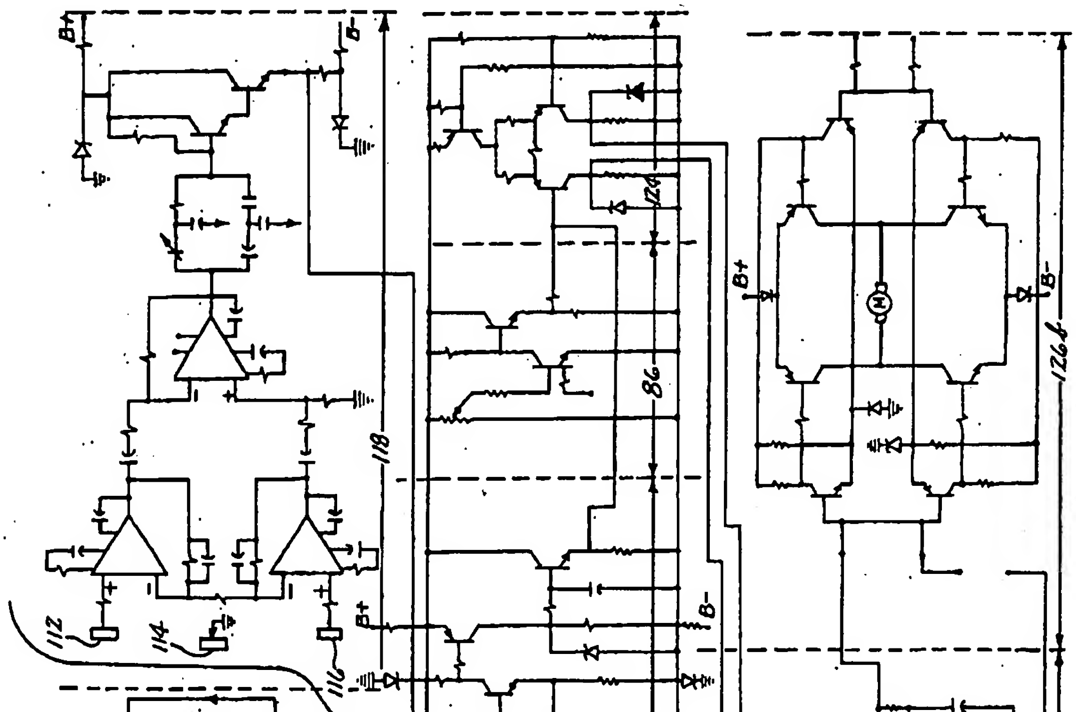


Fig. 6

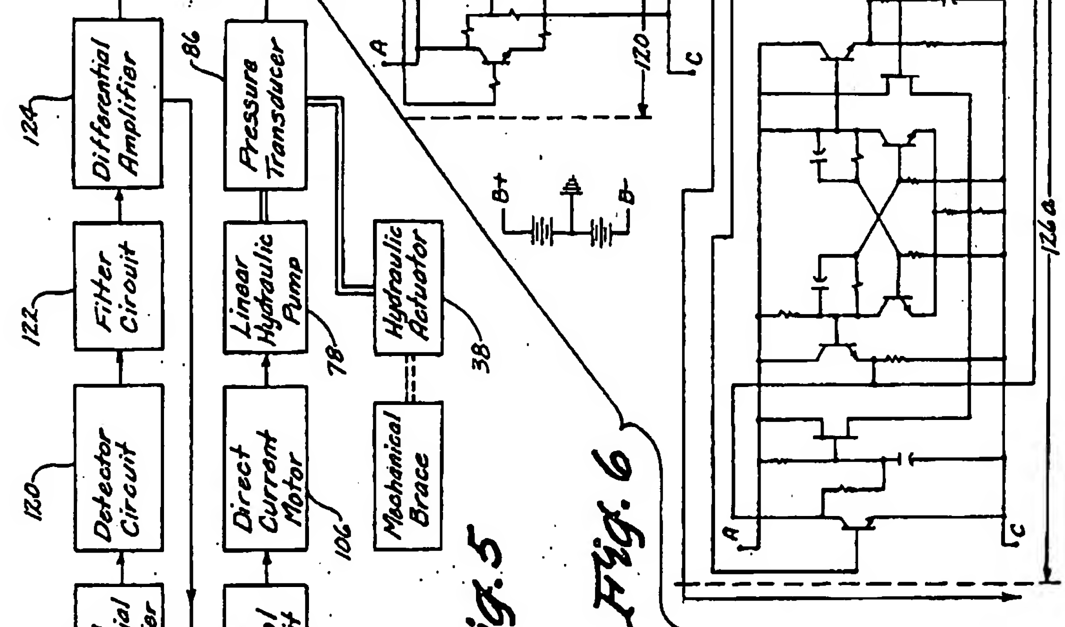
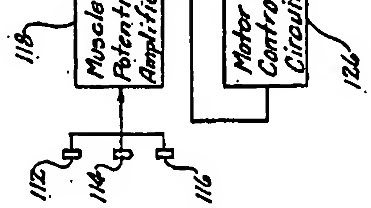


Fig. 5



INVENTOR
ALLAN G. POTTER
BY
Jarley, Miller & Thornton
ATTORNEYS

MYOELECTRIC BRACE

Electrically powered orthotic devices or braces for quadraplegic patients are convenient because the electrical power is readily available and is easily stored in the batteries which drive the electric motors on wheel chairs used by such patients. The utilization of other types of energy storage techniques by these patients requires the handling of another source of energy and thus, another set of operating conditions which is highly undesirable. In order to utilize the electrical energy stored in the wheel chair batteries to effectively power orthotic devices, one must optimize several conflicting requirements. First, both the weight and size of the brace-mounted actuator must be small. Second, the response and control of the limb brace when driven by the actuator must be normal. Third, minimum size, weight, and power consumption is desired for the complete device.

Therefore, it is a principal object of this invention to provide a myoelectric brace for quadraplegic patients.

A further object of this invention is to provide a myoelectric brace which is powered by a unique hydraulic system driven by a direct current battery operated motor.

A further object of this invention is to provide a myoelectric brace which is light weight.

A further object of this invention is to provide a myoelectric brace which has a minimum size and consumes a minimum of power.

A further object of this invention is to provide a myoelectric brace which is operated by the muscle potentials in the patient's arm.

A further object of this invention is to provide a myoelectric brace wherein muscle potentials are sensed by surface electrodes and are used to control finger position and tension in a proportional manner.

A further object of this invention is to provide a method of actuating a myoelectric brace.

A further object of this invention is to provide a myoelectric brace which is economical of manufacture, durable in use and refined in appearance.

These and other objects will be apparent to those skilled in the art.

This invention consists in the construction, arrangements, and combination of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in the claims, and illustrated in the accompanying drawings in which:

FIG. 1 is a side elevational view of the brace mounted on the patient's arm;

FIG. 2 is a top view of the brace as seen along lines 2—2 of FIG. 1;

FIG. 3 is a longitudinal sectional view of the hydraulic actuator as seen along lines 3—3 of FIG. 1;

FIG. 4 is a fragmentary longitudinal sectional view of the hydraulic pump as seen along lines 4—4 of FIG. 1;

FIG. 5 is a block diagram of the electrical circuitry of this invention; and

FIG. 6 is a schematic view of the electrical circuitry of this invention.

The numeral 10 generally designates a fixed wrist-hand splint of this invention which is adapted to be secured to the patient's lower arm, wrist and hand. Splint 10 includes a splint portion 12 which is secured to the patient's arm 14 by a strap 16 extending therearound and selectively closed by a Velcro fastener means 18 (FIG. 1). The upper end of splint portion 20 is pivotally connected to the lower end of splint portion 12 by a pin 22. Thumb support 24 extends downwardly from one end of splint portion 20 and is adapted to have the patient's thumb received therein (FIG. 1). A curved support 26 is pivotally secured at its upper end to splint portion 20 by a pin 28 and has spaced-apart, finger supports 30 and 32 extending laterally therefrom. As seen in FIG. 1, finger support 30 is adapted to have the patient's fingers extending therethrough while finger support 32 is adapted to extend over the patient's fingers. An arcuate hand support 34 is secured to splint portion 20 and extends laterally therefrom adapted to cup or support the underside of the patient's hand. Strap 36 extends around the patient's hand to firmly maintain the device thereon.

A hydraulic actuator 38 is secured to splint portion 20 by bracket 40 and has a push rod 42 slidably extending therefrom which is pivotally secured by a pin 44 to one of the adjustment holes 46 formed in ear 48 which extends from the rearward end of support 26. Thus, extension of push rod 42 from the hydraulic actuator 38 causes support 26 to pivot towards thumb support 24. Conversely, the withdrawal of push rod 42 into the actuator 38 causes support 26 to pivot away from the thumb support 24.

Hydraulic actuator 38 includes a piston head portion 50 secured to cylinder housing 52 by head screws 54. A bellowfram 56 is positioned between piston head portion 50 and cylinder housing 52 as seen in FIG. 3. A U-shaped piston 58 is secured to bellowfram 56 by a piston cap screw 60 extending through piston cap 62, bellowfram 56 and into piston 58.

Push rod 42 is secured to piston 58 and extends through spaced apart ball bushings 64 and 66 to reduce friction. A helical compression spring 68 embraces push rod 42 between piston 58 and support 70 and yieldably resists the extension of push rod 42 from housing 52. Nipple 72 extends from piston head portion 50 and is adapted to have a fluid line 74 connected thereto to place the fluid chamber 76 in actuator 38 in communication with pump 78. Pump 78 includes a hollow piston head 80 having a nipple 82 extending therefrom adapted to receive the fluid line 74 thereon. Pump 78 includes a fluid chamber 84 having a pressure transducer 86 extending thereinto. Pressure transducer 86 is provided with an electrical lead 88 which extends to a differential amplifier which will be discussed hereinafter.

A bellowfram 90 is positioned between piston head 80 and cylinder housing 92 by means of cap screws 94. A U-shaped piston 96 is secured to the center of bellowfram 90 by cap screws 98 extending through cap 100, bellowfram 90 and into piston 96.

The other end of piston 96 has an end plate 104 secured thereto which bears against the ball bearing screw nut 102 which runs in a groove of a grooved helical screw 116. Screw 116 is secured to the drive shaft 105 which rotatably extends from a battery operated, direct current motor 106. The numeral 108 refers to a coupling housing positioned between motor 106 and housing 92 and maintained therebetween by screws 110. An oldham coupling 120 connects motor 106 to screw 116.

Energization of the motor 106 causes power shaft 105 to rotate ball bearing screw 116. The rotation of screw 116 causes screw nut 102 to be moved along the groove of the screw 116 to cause spring 118 to drive piston 96 to the right as viewed in FIG. 4. Movement of piston 96 to the right causes the fluid in chamber 84 to be forced therefrom, through line 74 and into the fluid compartment of actuator 38. The fluid entering fluid compartment 76 in actuator 38 causes piston 58 to be moved to the left, as viewed in FIG. 3, which causes push rod 42 to be extended from the actuator 38 which in turn causes support 26, and hence the patient's fingers, to be moved towards the thumb support 24.

The numerals 112, 114 and 116 refer to the skin electrodes which are placed adjacent the skin surface of the patient's arm as indicated in FIG. 1 and maintained thereon by suitable means such as tape or the like. The electrodes are connected to a muscle potential amplifier generally referred to by the reference numeral 118 in FIGS. 5 and 6. If the patient desires to close his fingers, he tenses a muscle located near the skin surface electrodes. The resulting muscle potentials are then amplified by the muscle potential amplifier 118. This amplifier, FIG. 6, consists of a pair of operational amplifiers in a unity gain to common mode type circuit followed by a differential amplifier circuit, a parallel "T" rejection filter circuit, and a Darlington amplifier circuit. The amplified myopotentials are then put into a detector circuit 120, consisting of a Schmidt

trigger circuit followed by a low-pass filter circuit. This detector circuit transforms the amplified muscle potentials into a slowly varying control signal whose amplitude is related to the muscle tension causing it. If the output of the differential amplifier 124 is sufficiently large the motor control circuit 126 causes the motor 106 to drive the hydraulic pump 78 until a pressure related to the desired finger position plus tension is reached. The motor control circuit contains two identical control circuits consisting of a relaxation oscillator circuit which drives a hybrid timing circuit and a transistor bridge circuit. In this way both clockwise and counterclockwise rotation can be obtained depending upon which control circuit drives the transistor bridge circuit. The motor 106 stops when the signal from the pressure transducer 86 causes the differential amplifier 124 output signal to go below a set threshold level. If the patient wishes to open his fingers, he simply relaxes and the signal from the pressure transducer 86 causes the motor 106 to reduce the pressure so that the brace is driven to its zero muscle voltage position by the spring 68 contained in the actuator 38.

In summary, it can be seen that the myoelectric brace is driven by muscle potentials. The muscle potentials are created by tensing or contracting of the muscle which causes polarization of the muscle. The electrodes on the skin detect the E.M.G. differential and relays the same to the circuitry illustrated in the drawings. The pump 78 and actuator 38 are especially designed to reduce friction through the use of the ball bushings 64 and 66 and through the use of the foldable bellowfram incorporated therein.

A brace has been provided which is lightweight and which requires a minimum of power to be consumed during the operation thereof. The size of the brace is relatively small and is conveniently secured to the patient's arm. Finger position and tension is controlled in a proportional manner due to the muscle potentials being sensed by the surface electrodes and the relationship of the pressure transducer to the motor control circuit.

Thus it can be seen that the device accomplishes at least all of its stated objectives.

I claim:

1. In a myoelectric brace, comprising,

a splint means adapted to be secured to a person's arm and having a fixed wrist-hand splint portion and a movable finger support means pivotally connected thereto,

a hydraulic actuator means mounted on said fixed wrist-hand splint portion and being connected to said movable finger support means to cause said finger support means to be moved with respect to said fixed splint portion,

a hydraulic pump means fluidly connected to said actuator means adapted to cause said actuator means to move said finger support means,

a motor means for operating said pump means,

an electrode means adapted to be placed on the wearer's skin surface adjacent a muscle capable of being tensed by the wearer,

a circuit means connected to said electrode means adapted to sense the myo-potentials created by the tensing of said muscle and to transform the potentials into a control signal whereby said electric motor, said pump and said actuator will be operated so that said finger support means will be moved towards said fixed splint means, and

said pump means including a hollow piston head housing having a fluid compartment provided therein, said fluid compartment being in fluid communication with said actuator means, a cylinder housing connected to said piston head housing, a bellowfram between said piston head housing and said cylinder housing, a piston means in said cylinder housing connected to said bellowfram for movement therewith, a ball bearing screw rotatably mounted in said cylinder housing, a screw nut operatively connected to said piston means in engagement with said screw whereby rotation of said screw will cause said piston and said bellowfram to be moved, said motor having a drive shaft connected to said screw.

2. The brace of claim 1 wherein a pressure transducer is in communication with said fluid compartment in said piston head housing, said pressure transducer being electrically connected to said circuit means to stop said motor when a predetermined pressure is reached in said fluid compartment.

* * * * *